

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

1-3. (CANCELED)

4. (CURRENTLY AMENDED) A method for providing a foil, comprising:

(a) providing a foil having an inward portion, a tip portion, a lower surface, an upper surface, a leading edge and a trailing edge, said foil having relative movement to a fluid medium in a manner capable of creating an upward lifting force on said foil relative to the plane of said relative movement, said upward lifting force is substantially directed from said lower surface toward said upper surface;

(b) providing said foil with a vortex generator connected to said foil near said tip portion, said vortex generator having a substantially streamwise alignment relative to said foil between a vortex generator leading edge and a vortex generator trailing edge that is oriented at a predetermined angle of attack relative to said relative movement, said vortex generator extending below said lower surface of said foil and terminating at a lower end of said vortex generator, said vortex generator

having an outward surface and an inward surface, said inward surface being arranged to form a region of relatively lower pressure along said inward surface relative to said outward surface so as to create an inward directed lifting force on said vortex generator that is substantially directed from said outward surface toward said inward surface, said inward directed lifting force being sufficient to create an inward directed cross flow condition in the wake behind said lower end of said vortex generator that is substantially directed from said tip portion of said foil toward said inward portion of said foil relative to said lower surface of said foil; ~~and~~

(c) arranging the direction of said inward lifting force created by said vortex generator to be oriented sufficiently perpendicular to said upward lifting force created by said foil to substantially prevent a significantly strong downward directed vector component of said inward lifting force from forming on said vortex generator which could significantly oppose said upward lifting force generated by said foil, wherein said inward lifting force on said vortex generator is able to create said inward directed cross flow without simultaneously creating a significant reduction in said upward lifting force on said foil; and

d) wherein said inward surface has a predetermined contour capable of forming a forward directed vector component of said inward lifting force along said inward surface.

5. (CANCELED)

6. (CURRENTLY AMENDED) A method for providing a foil, comprising:

(a) providing a foil having an inward portion, a tip portion, a lower surface, an upper surface, a leading edge and a trailing edge, said foil having relative movement to a fluid medium in a manner capable of creating an upward lifting force on said foil relative to the plane of said relative movement, said upward lifting force is substantially directed from said lower surface toward said upper surface;

(b) providing said foil with a vortex generator connected to said foil near said tip portion, said vortex generator having a substantially streamwise alignment relative to said foil between a vortex generator leading edge and a vortex generator trailing edge that is oriented at a predetermined angle of attack relative to said relative movement, said vortex generator extending below said lower surface of said foil and terminating at a lower end of said vortex generator, said vortex generator

having an outward surface and an inward surface, said inward surface being arranged to form a region of relatively lower pressure along said inward surface relative to said outward surface so as to create an inward directed lifting force on said vortex generator that is substantially directed from said outward surface toward said inward surface, said inward directed lifting force being sufficient to create an inward directed cross flow condition in the wake behind said lower end of said vortex generator that is substantially directed from said tip portion of said foil toward said inward portion of said foil relative to said lower surface of said foil; and

(d) arranging the direction of said inward lifting force created by said vortex generator to be oriented sufficiently perpendicular to said upward lifting force created by said foil to substantially prevent a significantly strong downward directed vector component of said inward lifting force from forming on said vortex generator which could significantly oppose said upward lifting force generated by said foil, wherein said inward lifting force on said vortex generator is able to create said inward directed cross flow without simultaneously creating a significant reduction in said upward lifting force on said foil; and

d) ~~The method of Claim 4~~ wherein said inward surface has a predetermined contour capable of tilting said inward lifting force toward the direction of relative movement of said foil.

7. (CANCELED)

8. (CANCELED)

9. (CURRENTLY AMENDED) A method for providing a foil, comprising:

(a) providing a foil having an inward portion, a tip portion, a lower surface, an upper surface, a leading edge and a trailing edge, said foil having relative movement to a fluid medium in a manner capable of creating an upward lifting force on said foil relative to the plane of said relative movement, said upward lifting force is substantially directed from said lower surface toward said upper surface;

(b) providing said foil with a vortex generator connected to said foil near said tip portion, said vortex generator having a substantially streamwise alignment relative to said foil between a vortex generator leading edge and a vortex generator trailing edge that is oriented at a predetermined angle of attack relative to said relative movement, said vortex generator

extending below said lower surface of said foil and terminating at a lower end of said vortex generator, said vortex generator having an outward surface and an inward surface, said inward surface being arranged to form a region of relatively lower pressure along said inward surface relative to said outward surface so as to create an inward directed lifting force on said vortex generator that is substantially directed from said outward surface toward said inward surface, said inward directed lifting force being sufficient to create an inward directed cross flow condition in the wake behind said lower end of said vortex generator that is substantially directed from said tip portion of said foil toward said inward portion of said foil relative to said lower surface of said foil; and

(c)arranging the direction of said inward lifting force created by said vortex generator to be oriented sufficiently perpendicular to said upward lifting force created by said foil to substantially prevent a significantly strong downward directed vector component of said inward lifting force from forming on said vortex generator which could significantly oppose said upward lifting force generated by said foil, wherein said inward lifting force on said vortex generator is able to create said inward directed cross flow without simultaneously

creating a significant reduction in said upward lifting force on said foil; and

(d) ~~The method of Claim 4~~ wherein said inward surface has a predetermined convex cambered contour capable of forming a forward directed vector component of said inward lifting force along said inward surface.

10-13. (CANCELED)

14. (CURRENTLY AMENDED) A method for providing a foil, comprising:

(a) providing a foil having an inward portion, a tip portion, a lower surface, an upper surface, a leading edge and a trailing edge, said foil having relative movement to a fluid medium in a manner capable of creating an upward lifting force on said foil relative to the plane of said relative movement, said upward lifting force is substantially directed from said lower surface toward said upper surface;

(b) providing said foil with a vortex generator connected to said foil near said tip portion, said vortex generator having a substantially streamwise alignment relative to said foil between a vortex generator leading edge and a vortex generator trailing edge that is oriented at a predetermined angle of attack

relative to said relative movement, said vortex generator
extending below said lower surface of said foil and terminating
at a lower end of said vortex generator, said vortex generator
having an outward surface and an inward surface, said inward
surface being arranged to form a region of relatively lower
pressure along said inward surface relative to said outward
surface so as to create an inward directed lifting force on said
vortex generator that is substantially directed from said
outward surface toward said inward surface, said inward directed
lifting force being sufficient to create an inward directed
cross flow condition in the wake behind said lower end of said
vortex generator that is substantially directed from said tip
portion of said foil toward said inward portion of said foil
relative to said lower surface of said foil; and

(c) arranging the direction of said inward lifting force
created by said vortex generator to be oriented sufficiently
perpendicular to said upward lifting force created by said foil
to substantially prevent a significantly strong downward
directed vector component of said inward lifting force from
forming on said vortex generator which could significantly
oppose said upward lifting force generated by said foil, wherein
said inward lifting force on said vortex generator is able to
create said inward directed cross flow without simultaneously

creating a significant reduction in said upward lifting force on said foil;

(d) wherein said foil has a tendency to create an outward directed cross flow condition relative to said lower surface near said tip portion and said inward directed cross flow condition created by said vortex generator is sufficient to create a reduction in said outward cross flow condition; and

~~(e) The method of Claim 13~~ wherein said outward directed cross flow condition has a tendency to create an induced drag vortex in said wake behind said tip portion and said inward directed cross flow condition is sufficient to move said induced drag tip vortex to a position within said wake that is inward of said vortex generator.

15. (CANCELED)

16. (CURRENTLY AMENDED) A method for providing a foil, comprising:

(a) providing a foil having an inward portion, a tip portion, a lower surface, an upper surface, a leading edge and a trailing edge, said foil having relative movement to a fluid medium in a manner capable of creating an upward lifting force on said foil relative to the plane of said relative movement,

said upward lifting force is substantially directed from said lower surface toward said upper surface;

(b) providing said foil with a vortex generator connected to said foil near said tip portion, said vortex generator having a substantially streamwise alignment relative to said foil between a vortex generator leading edge and a vortex generator trailing edge that is oriented at a predetermined angle of attack relative to said relative movement, said vortex generator extending below said lower surface of said foil and terminating at a lower end of said vortex generator, said vortex generator having an outward surface and an inward surface, said inward surface being arranged to form a region of relatively lower pressure along said inward surface relative to said outward surface so as to create an inward directed lifting force on said vortex generator that is substantially directed from said outward surface toward said inward surface, said inward directed lifting force being sufficient to create an inward directed cross flow condition in the wake behind said lower end of said vortex generator that is substantially directed from said tip portion of said foil toward said inward portion of said foil relative to said lower surface of said foil;and

(c) arranging the direction of said inward lifting force

created by said vortex generator to be oriented sufficiently perpendicular to said upward lifting force created by said foil to substantially prevent a significantly strong downward directed vector component of said inward lifting force from forming on said vortex generator which could significantly oppose said upward lifting force generated by said foil, wherein said inward lifting force on said vortex generator is able to create said inward directed cross flow without simultaneously creating a significant reduction in said upward lifting force on said foil; and

(d) ~~The method of Claim 4~~ wherein said tip portion of said foil has a tendency to create an induced drag vortex in said wake behind said tip portion and said inward directed cross flow condition is arranged to create a counter vortex in said wake behind said vortex generator that has a direction of spin that is opposite to said induced drag vortex.

17. (PREVIOUSLY PRESENTED) The method of Claim 16 wherein said counter vortex is arranged to merge with said induced drag vortex in said wake behind said foil in an amount sufficient to create a reduction in the strength of said induced drag vortex.

18. (PREVIOUSLY PRESENTED) The method of Claim 16 wherein said induced drag vortex and said counter vortex are arranged to form a converging upwash field in said wake behind said foil at a position that is inward of said tip portion.

19. (PREVIOUSLY PRESENTED) The method of Claim 16 wherein said induced drag vortex creates a downwash field in said wake behind said foil and said counter vortex is arranged to create an upwash field in said wake behind said vortex generator, said upwash field being sufficient to create a reduction in the strength of said downwash field.

20-22. (CANCELED)

23. (CURRENTLY AMENDED) A foil tip comprising a tip droop extending below a high pressure surface of a foil and terminating at a lower end of said tip droop, said tip droop having a droop leading edge, a droop trailing edge, an inward droop surface and an outward droop surface, said tip droop having a predetermined chord line between said droop leading edge and said droop trailing edge, said tip droop having a

predetermined asymmetrical foil shape along said predetermined chord line that is arranged to create a region of reduced pressure along said inward droop surface of said tip droop,
~~The method of Claim 22~~ wherein said region of reduced pressure along said inward droop surface forms an inward lifting force along said inward surface, said inward droop surface having a predetermined contour capable of creating a forward directed vector component of said inward lifting force.

24. (CURRENTLY AMENDED) A foil tip comprising a tip droop extending below a high pressure surface of a foil and terminating at a lower end of said tip droop, said tip droop having a .droop leading edge, a droop trailing edge, an inward droop surface and an outward droop surface, said tip droop having a predetermined chord line between said droop leading edge and said droop trailing edge, said tip droop having a predetermined asymmetrical foil shape along said predetermined chord line that is arranged to create a region of reduced pressure along said inward droop surface of said tip droop,
~~The method of Claim 22~~ wherein said foil has relative movement to a fluid medium, said region of reduced pressure along said inward droop surface forms an inward lifting force along said

inward surface, said inward droop surface having a predetermined contour capable of tilting said inward lifting force toward said direction of relative movement of said foil.

25 - 38. (CANCELED)

39. (CURRENTLY AMENDED) A method for providing a vortex generator comprising:

(a) providing a substantially streamwise foil extending from a predetermined surface of a predetermined body, said predetermined surface having relative movement to a fluid medium capable of forming a predetermined boundary layer having a predetermined boundary layer thickness within said fluid medium along said predetermined surface, said streamwise foil having a substantially streamwise alignment with a predetermined chord length existing between a vortex generator leading edge and a vortex generator trailing edge, said substantially streamwise foil having a lower pressure surface, a higher pressure surface, a root portion adjacent said surface and an outer end portion spaced from said predetermined surface and said root portion wherein said outer end portion extends a predetermined height away from said predetermined surface of said predetermined body;

(b) providing said streamwise foil with a significantly low aspect ratio wherein said predetermined height of said streamwise foil is significantly smaller than said predetermined chord length of said streamwise foil, and

(c) providing said lower pressure surface with a predetermined lift inducing camber arranged to create a lifting force that is substantially transverse to said substantially streamwise alignment, said predetermined lift inducing camber being sufficient to create a substantially transverse flow, condition relative to said outer end portion of said vortex generator, said substantially transverse flow condition occurring substantially in a direction from said higher pressure surface toward said lower pressure surface, said transverse flow condition being sufficient to permit said streamwise foil to form a substantially streamwise vortex in the wake behind said vortex generator and said predetermined height of said vortex generator being sufficiently low enough to permit at least one portion of said substantially streamwise vortex to exist within said predetermined boundary layer along said predetermined surface, whereby said substantially streamwise vortex is capable of adding energy into said predetermined boundary layer,
~~The method of Claim 38~~ wherein said lower pressure surface is arranged to have a predetermined contour capable of forming a

forward directed vector component of said lifting force that is substantially directed in the direction of said relative movement.

40. (CURRENTLY AMENDED) A method for providing a vortex generator comprising:

(a) providing a substantially streamwise foil extending from a predetermined surface of a predetermined body, said predetermined surface having relative movement to a fluid medium capable of forming a predetermined boundary layer having a predetermined boundary layer thickness within said fluid medium along said predetermined surface, said streamwise foil having a substantially streamwise alignment with a predetermined chord length existing between a vortex generator leading edge and a vortex generator trailing edge, said substantially streamwise foil having a lower pressure surface, a higher pressure surface, a root portion adjacent said surface and an outer end portion spaced from said predetermined surface and said root portion wherein said outer end portion extends a predetermined height away from said predetermined surface of said predetermined body;

(b) providing said streamwise foil with a significantly low aspect ratio wherein said predetermined height of said

streamwise foil is significantly smaller than said predetermined chord length of said streamwise foil, and

(c) providing said lower pressure surface with a predetermined lift inducing camber arranged to create a lifting force that is substantially transverse to said substantially streamwise alignment, said predetermined lift inducing camber being sufficient to create a substantially transverse flow, condition relative to said outer end portion of said vortex generator, said substantially transverse flow condition occurring substantially in a direction from said higher pressure surface toward said lower pressure surface, said transverse flow condition being sufficient to permit said streamwise foil to form a substantially streamwise vortex in the wake behind said vortex generator and said predetermined height of said vortex generator being sufficiently low enough to permit at least one portion of said substantially streamwise vortex to exist within said predetermined boundary layer along said predetermined surface, whereby said substantially streamwise vortex is capable of adding energy into said predetermined boundary layer,

~~The method of Claim 38~~ wherein said lower pressure surface is arranged to have a predetermined contour capable of tilting said lifting force toward the direction of said relative movement.

Appl. No. 10/606,265

41-48. (CANCELED)